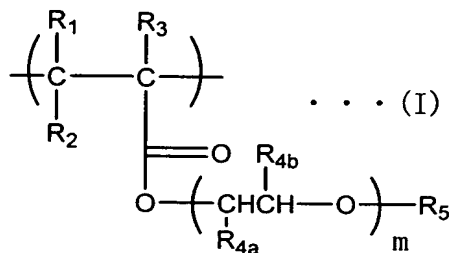
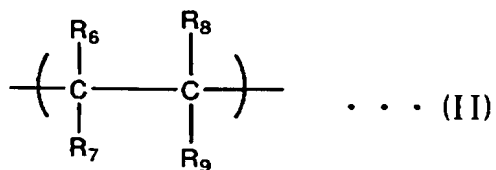


Claims

1. A composition for a polymer solid electrolyte comprising a copolymer having repeating units represented by Formula (I):



(wherein each of R₁ to R₃ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₁ and R₃ may bond to one another to form a ring; each of R_{4a} and R_{4b} independently represents a hydrogen atom or a methyl group; R₅ represents a hydrogen atom, a hydrocarbon group, an acyl group or a silyl group; m is an integer of 1 to 100, and each of R_{4a} and each of R_{4b} may be the same or different when m is 2 or more) and repeating units represented by Formula (II):



(wherein each of R₆ and R₈ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₆ and R₈ may bond to one another to form a ring; and R₇ represents a hydrogen atom, a C1-C10 hydrocarbon group, a hydroxyl group, a hydrocarbonoxy group, a carboxyl group, an acid anhydride group, an amino group, an ester group, or an organic group having at least one functional group selected from the group consisting of

hydroxyl group, carboxyl group, epoxy group, acid anhydride group and amino group; R₉ represents an organic group having at least one functional group selected from the group consisting of hydroxyl group, carboxyl group, epoxy group, acid anhydride group and amino group); and an electrolyte salt.

2. A composition for a polymer solid electrolyte according to Claim 1, further comprising a cross-linking agent.

3. A composition for a polymer solid electrolyte according to Claim 1 or 2, wherein the amount of the cross-linking agent is 0.01 to 2 mol with respect to one mole of the repeating unit represented by the Formula (II).

4. A composition for a polymer solid electrolyte according to Claim 1 or 2, wherein the amount of the cross-linking agent is 0.1 to 1 mole with respect to one mole of the repeating unit represented by the Formula (II).

5. A composition for a polymer solid electrolyte according to any one of Claims 1 to 4, wherein 5 moles or more of the repeating unit represented by the Formula (I) is included in the copolymer having the repeating units represented by the Formula (I) and the Formula (II).

6. A composition for a polymer solid electrolyte according to any one of Claims 1 to 5, wherein 5 moles or more of the repeating unit represented by the Formula (II) is included in the copolymer having the repeating units represented by the Formula (I) and the Formula (II).

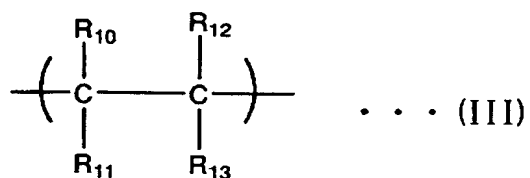
7. A composition for a polymer solid electrolyte according to any one of Claims 1 to 6, wherein a number of moles of the repeating unit represented by the Formula (I) is within a range of 5 to 99% with respect to a number of moles of the total repeating units in the copolymer, and a number of moles of the repeating unit represented by the Formula (II) is within a range of 1 to 95% with respect to a number of moles of a total repeating units in the copolymer.

8. A composition for a polymer solid electrolyte according to any one of Claims 1 to 7, wherein the repeating unit represented by the Formula (I) and the repeating unit represented by the Formula (II) are block bonded.

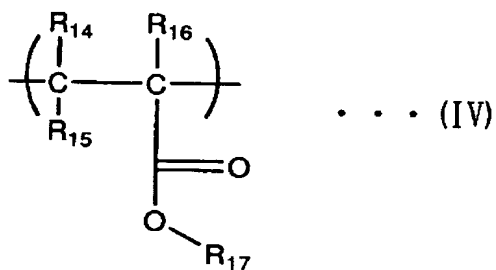
9. A composition for a polymer solid electrolyte according to any one of Claims 1 to 8, wherein the copolymer having the repeating units represented by the Formula (I) and the Formula (II) further includes a repeating unit derived from a polymerizable unsaturated monomer, which is different from the repeating units represented by the Formula (I) and the

Formula (II).

10. A composition for a polymer solid electrolyte according to Claim 9, wherein the repeating unit derived from polymerizable unsaturated monomers, different from those represented by the Formulae (I) and (II), is at least one repeating unit selected from those represented by Formula (III)



(wherein each of R₁₀ to R₁₂ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group, and R₁₃ represents an aryl group or a heteroaryl group); and Formula (IV)



(wherein each of R₁₄ to R₁₆ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; R₁₄ and R₁₆ may bond to one another to form a ring; and R₁₇ represents a C₁-C₁₂ alkyl group, an aryl group, an alicyclic hydrocarbon group, or a heterocyclic group).

11. A composition for a polymer solid electrolyte according to Claim 9

or 10, wherein 5 moles or more of the repeating unit derived from polymerizable unsaturated monomer, which is different from those represented by the Formulae (I) and (II) is included.

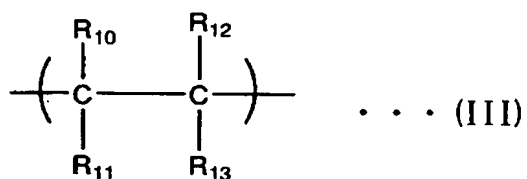
12. A composition for a polymer solid electrolyte according to any one of Claims 9 to 11, wherein the repeating unit represented by the Formula (I), the repeating unit represented by the Formula (II), and the repeating unit derived from polymerizable unsaturated monomer different from those represented by the Formula (I) and the Formula (II) are block bonded.

13. A composition for a polymer solid electrolyte according to any one of Claims 9 to 12, wherein a total number of moles of the repeating unit represented by the Formula (I) and the repeating unit derived from polymerizable unsaturated monomer, different from those represented by the Formula (I) and the Formula (II), is within the range of 5-99% with respect to a total number of repeating units in the copolymer, and a number of moles of the repeating unit represented by the Formula (II) is within the range of 1-95% with respect to the total number of repeating units in the copolymer.

14. A composition for a polymer solid electrolyte according to any one of Claims 9 to 13, wherein, with respect to a total number of moles of the

repeating units in the copolymer, a number of moles of the repeating unit represented by the Formula (I) is within a range of 9.9-80%, a number of moles of the repeating unit represented by the Formula (II) is within a range of 0.1-50%, and a number of moles of the repeating unit derived from polymerizable unsaturated monomer, different from those represented by the Formula (I) and the Formula (II), is within a range of 19.9-90%.

15. A composition for a polymer solid electrolyte according to any one of Claims 1 to 14, wherein the copolymer having the repeating units represented by the Formula (I) and the Formula (II) is a copolymer having an arrangement of block chains in an order of B1, C1, A, C2, and B2, wherein the block chain A has the repeating unit represented by the Formula (I); the block chain B1 has the repeating unit represented by the Formula (II), the block chain B2 has the repeating unit represented by the Formula (II) which may be the same or different from B1; the block chain C1 has a repeating unit represented by the Formula (III)



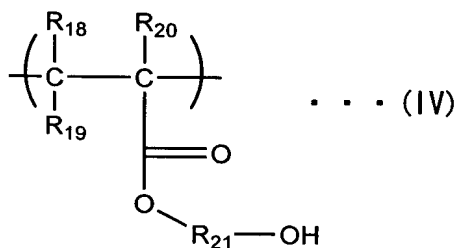
(wherein each of R₁₀ to R₁₂ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group, and R₁₃ represents an aryl group or a heteroaryl group); and the block chain C2 has a repeating unit represented by the

Formula (III) which may be the same or different from C1.

16. A composition for a polymer solid electrolyte according to Claim 15, wherein the arrangement of B1, C1, A, C2, and B2 is an arrangement in which units of B1-C1-A-C2-B2 are bonded.

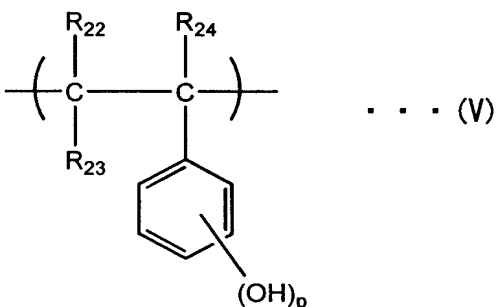
17. A composition for a polymer solid electrolyte according to any one of Claims 1 to 16, wherein a number average molecular weight of the copolymer having repeating units represented by the Formula (I) and the Formula (II) is within the range of 5,000 to 1,000,000.

18. A composition for a polymer solid electrolyte according to any one of Claims 1 to 17, wherein the repeating unit represented by the Formula (II) is a repeating unit represented by Formula (IV):

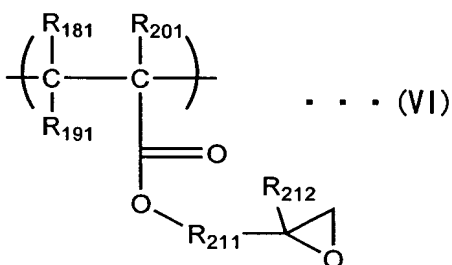


(wherein each of R₁₈ to R₂₀ independently represents a hydrogen atom or a

C1-C10 hydrocarbon group; R₁₈ and R₂₀ may bond to one another to form a ring; and R₂₁ represents a C1-C6 alkylene group, a C6-C10 bivalent aromatic hydrocarbon group, a C3-C10 bivalent alicyclic hydrocarbon group, or a bivalent organic group of a complex thereof), or a repeating unit represented by Formula (V)

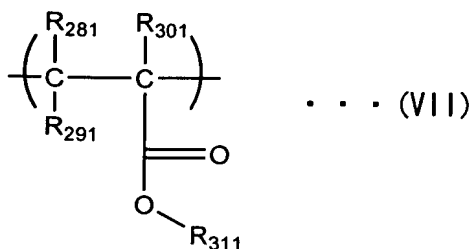


(wherein each of R₂₂ to R₂₄ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; and p represents an integer of 1 to 3), or a repeating unit represented by Formula (VI)

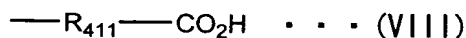


(wherein each of R₁₈₁, R₁₉₁, and R₂₀₁ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₁₈₁ and R₂₀₁ may bond to one another to form a ring; R₂₁₁ represents a C1-C6 alkylene group, a C6-C10 bivalent aromatic hydrocarbon group, a C3-C10 bivalent alicyclic hydrocarbon group or a bivalent organic group of a complex thereof; and

R₂₁₂ represents a hydrogen atom or a C1-C4 alkyl group), or a repeating unit represented by Formula (VII)



(wherein each of R₂₈₁, R₂₉₁ and R₃₀₁ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₂₈₁ and R₃₀₁ may bond to one another to form a ring; and R₃₁₁ represents a hydrogen atom or a functional group represented by Formula (VIII)



(wherein R₄₁₁ represents a C1-C6 alkylene group, a C6-C10 bivalent aromatic hydrocarbon group, a C3-C10 bivalent alicyclic hydrocarbon group or a bivalent organic group of a complex thereof)).

19. A composition for a polymer solid electrolyte according to any one of Claims 1 to 18, wherein the copolymer has a microphase-separated structure.

20. A composition for a polymer solid electrolyte according to any one of Claims 2 to 19, wherein the cross-linking agent is a polyisocyanate compound including two or more isocyanate groups within its molecule, or an epoxy compound including two or more epoxy groups within its

molecule.

21. A composition for a polymer solid electrolyte according to any one of Claims 2 to 19, wherein the repeating unit represented by the Formula (II) is a repeating unit derived from a (meth)acrylate derivative having an epoxy group; and the cross-linking agent is an epoxy hardener.

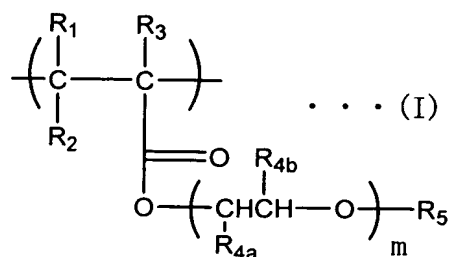
22. A composition for a polymer solid electrolyte according to any one of Claims 2 to 19, wherein R_9 in the repeating unit represented by the Formula (II) is an organic group having a carboxyl group, and the cross-linking agent is an epoxy compound including two or more epoxy groups within its molecule.

23. A composition for a polymer solid electrolyte according to any one of Claims 1 to 22, wherein the electrolyte salt is at least one selected from the group consisting of alkali metal salts, quaternary ammonium salts, quaternary phosphonium salts, transition metal salts, and protonic acids.

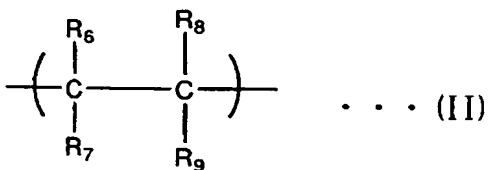
24. A composition for a polymer solid electrolyte according to any one of Claims 1 to 23, wherein the electrolyte salt is a lithium salt.

25. A polymer solid electrolyte, comprising: a copolymer having

repeating units represented by Formula (I):



(wherein each of R₁-R₃ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; R₁ and R₃ may bond to one another to form a ring; each of R_{4a} and R_{4b} independently represents a hydrogen atom or a methyl group; R₅ represents a hydrogen atom, a hydrocarbon group, an acyl group or a silyl group; m is an integer of 1 to 100, and each of R_{4a} and R_{4b} may be the same or different when m is 2 or more) and repeating units represented by Formula (II):

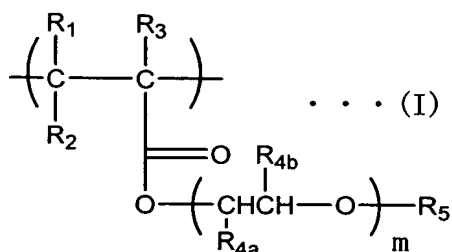


(wherein each of R₆ and R₈ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; R₆ and R₈ may bond to one another to form a ring; and R₇ represents a hydrogen atom, a C₁-C₁₀ hydrocarbon group, a hydroxyl group, a hydrocarbonoxy group, a carboxyl group, an acid anhydride group, an amino group, an ester group, or an organic group having at least one functional group selected from the group consisting of hydroxyl group, carboxyl group, epoxy group, acid anhydride group and amino group; R₉ represents an organic group having at least one functional

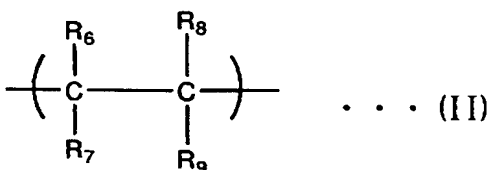
group selected from the group consisting of hydroxyl group, carboxyl group, epoxy group, acid anhydride group and amino group); and an electrolyte salt.

26. A polymer solid electrolyte, comprising:

a cross-linked polymer obtained by a reaction of a cross-linking agent with a copolymer having repeating units represented by Formula (I):



(wherein each of R₁-R₃ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; R₁ and R₃ may bond to one another to form a ring; each of R_{4a} and R_{4b} independently represents a hydrogen atom or a methyl group; R₅ represents a hydrogen atom, a hydrocarbon group, an acyl group or a silyl group; m is an integer of 1 to 100, and each of R_{4a} and each of R_{4b} may be the same or different when m is 2 or more) and repeating units represented by Formula (II):



(wherein each of R₆ and R₈ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; R₆ and R₈ may bond to one another to form a

ring; and R7 represents a hydrogen atom, a C1-C10 hydrocarbon group, a hydroxyl group, a hydrocarbonoxy group, a carboxyl group, an acid anhydride group, an amino group, an ester group, or an organic group having at least one functional group selected from the group consisting of hydroxyl group, carboxyl group, epoxy group, acid anhydride group and amino group; R9 represents an organic group having at least one functional group selected from the group consisting of hydroxyl group, carboxyl group, epoxy group, acid anhydride group and amino group); and an electrolyte salt.

27. A polymer solid electrolyte according to Claim 26, wherein the cross-linking agent is used in the range of 0.01 to 2 mole with respect to one mole of the repeating unit represented by the Formula (II).

28. A polymer solid electrolyte according to Claim 26, wherein the cross-linking agent is used in the range of 0.1 to 1 mole with respect to one mole of the repeating units represented by the Formula (II).

29. A polymer solid electrolyte according to any one of Claims 25 to 28, wherein an amount of the repeating unit represented by the Formula (I) is 5 moles or more in the copolymer having repeating units represented by the Formula (I) and the Formula (II).

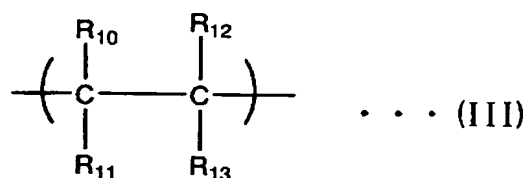
30. A polymer solid electrolyte according to any one of Claims 25 to 29, wherein an amount of the repeating unit represented by the Formula (II) is 5 moles or more in the copolymer having repeating units represented by the Formula (I) and the Formula (II).

31. A polymer solid electrolyte according to any one of Claims 25 to 30, wherein a number of moles of the repeating unit represented by the Formula (I) is within a range of 5 to 99% with respect to a number of moles of a total repeating units in the copolymer, and a number of moles of the repeating unit represented by the Formula (II) is within a range of 1 to 95% with respect to a number of moles of a total repeating units in the copolymer.

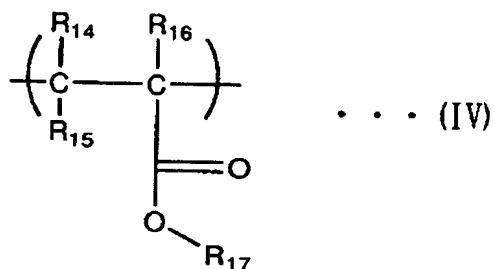
32. A polymer solid electrolyte according to any one of Claims 25 to 31, wherein the repeating unit represented by the Formula (I) and the repeating unit represented by the Formula (II) are block bonded.

33. A polymer solid electrolyte according to any one of Claims 25 to 32, wherein the copolymer having the repeating units represented by the Formula (I) and the Formula (II) further includes a repeating unit derived from a polymerizable unsaturated monomer, which is different from the repeating units represented by the Formula (I) and the Formula (II).

34. A polymer solid electrolyte according to Claim 33, wherein the repeating unit derived from polymerizable unsaturated monomers, different from those represented by the Formulae (I) and (II), is at least one repeating unit selected from those represented by Formula (III)



(wherein each of R₁₀ to R₁₂ independently represents a hydrogen atom or a C1-C10 hydrocarbon group, and R₁₃ represents an aryl group or a heteroaryl group); and Formula (IV)



(wherein each of R₁₄ to R₁₆ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₁₄ and R₁₆ may bond to one another to form a ring; and R₁₇ represents a C1-C12 alkyl group, an aryl group, an alicyclic hydrocarbon group, or a heterocyclic group).

35. A polymer solid electrolyte according to Claim 33 or 34, wherein 5 moles or more of the repeating unit derived from polymerizable unsaturated

monomer, which is different from those represented by the Formulae (I) and (II) is included.

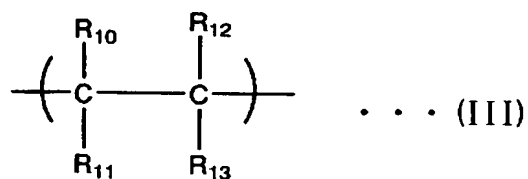
36. A polymer solid electrolyte according to any one of Claims 33 to 35, wherein the repeating unit represented by the Formula (I), the repeating unit represented by the Formula (II), and the repeating unit derived from polymerizable unsaturated monomer different from those represented by the Formula (I) and the Formula (II) are block bonded.

37. A polymer solid electrolyte according to any one of Claims 33 to 36, wherein a total number of moles of the repeating unit represented by the Formula (I) and the repeating unit derived from polymerizable unsaturated monomer, different from those represented by the Formula (I) and the Formula (II), is within a range of 5-99% with respect to a total number of repeating units in the copolymer, and a number of moles of the repeating unit represented by the Formula (II) is within a range of 1-95% with respect to the total number of repeating units in the copolymer.

38. A polymer solid electrolyte according to any one of Claims 33 to 37, wherein, with respect to a total number of moles of the repeating units in the copolymer, a number of moles of the repeating unit represented by the Formula (I) is within a range of 9.9-80%, a number of moles of the

repeating unit represented by the Formula (II) is within a range of 0.1-50%, and a number of moles of the repeating unit derived from polymerizable unsaturated monomer, different from those represented by the Formula (I) and the Formula (II), is within a range of 19.9-90%.

39. A polymer solid electrolyte according to any one of Claims 25 to 38, wherein the copolymer having the repeating units represented by the Formula (I) and the Formula (II) is a copolymer having an arrangement of block chains in an order of B1, C1, A, C2, and B2, wherein the block chain A has the repeating unit represented by the Formula (I); the block chain B1 has the repeating unit represented by the Formula (II), the block chain B2 has the repeating unit represented by the Formula (II) which may be the same or different from B1; the block chain C1 has a repeating unit represented by the Formula (III):



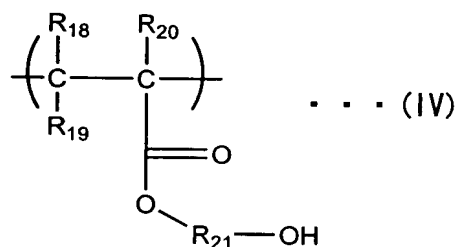
(wherein each of R₁₀ to R₁₂ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group, and R₁₃ represents an aryl group or a heteroaryl group); and the block chain C2 has a repeating unit represented by the Formula (III) which may be the same or different from C1.

40. A polymer solid electrolyte according to Claim 39, wherein the arrangement of B1, C1, A, C2, and B2 is an arrangement in which units of B1-C1-A-C2-B2 are bonded.

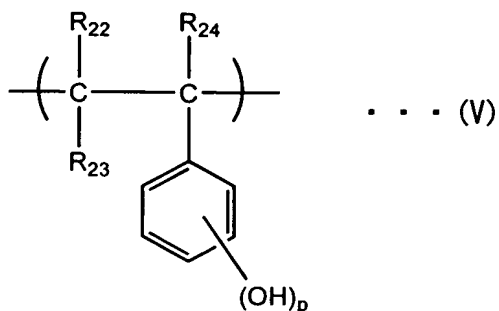
41. A polymer solid electrolyte according to any one of Claims 25 to 40, wherein a number average molecular weight of the copolymer having repeating units represented by the Formula (I) and the Formula (II) is within the range of 5,000 to 1,000,000.

42. A polymer solid electrolyte according to any one of Claims 25 to 41, wherein the repeating unit represented by the Formula (II) is a repeating unit represented by Formula (IV):

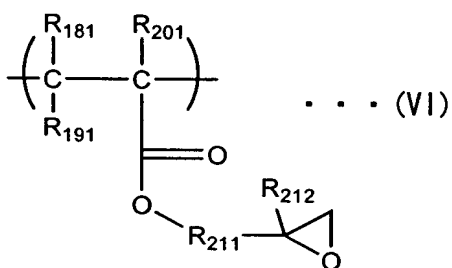
(wherein each of R₁₈ to R₂₀ independently represents a hydrogen atom or a



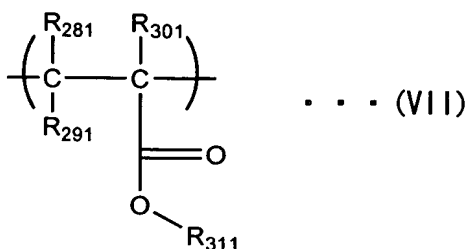
C₁-C₁₀ hydrocarbon group; R₁₈ and R₂₀ may bond to one another to form a ring; and R₂₁ represents a C₁-C₆ alkylene group, a C₆-C₁₀ bivalent aromatic hydrocarbon group, a C₃-C₁₀ bivalent alicyclic hydrocarbon group, or a bivalent organic group of a complex thereof), or a repeating unit represented by Formula (V):



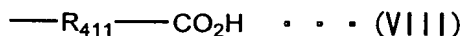
(wherein each of R₂₂ to R₂₄ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; and p represents an integer of 1 to 3), or a repeating unit represented by Formula (VI):



(wherein each of R₁₈₁, R₁₉₁, and R₂₀₁ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₁₈₁ and R₂₀₁ may bond to one another to form a ring; R₂₁₁ represents a C1-C6 alkylene group, a C6-C10 bivalent aromatic hydrocarbon group, a C3-C10 bivalent alicyclic hydrocarbon group or a bivalent organic group of a complex thereof; and R₂₁₂ represents a hydrogen atom or a C1-C4 alkyl group), or a repeating unit represented by Formula (VII):



(wherein each of R₂₈₁, R₂₉₁ and R₃₀₁ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₂₈₁ and R₃₀₁ may bond to one another to form a ring; and R₃₁₁ represents a hydrogen atom or a functional group represented by Formula (VIII))



(wherein R₄₁₁ represents a C1-C6 alkylene group, a C6-C10 bivalent aromatic hydrocarbon group, a C3-C10 bivalent alicyclic hydrocarbon group or a bivalent organic group of a complex thereof)).

43. A polymer solid electrolyte according to any one of Claims 25 to 42, wherein the cross-linked polymer is a copolymer having a microphase-separated structure.

44. A polymer solid electrolyte according to any one of Claims 25 to 43, characterized by having a network type microphase-separated structure.

45. A polymer solid electrolyte according to any one of Claims 26 to 44, wherein the cross-linked polymer has urethane bonding derived from the cross-linking agent.

46. A polymer solid electrolyte according to any one of Claims 26 to 45, wherein the cross-linking agent is a polyisocyanate compound including two or more isocyanate groups within its molecule, or an epoxy compound including two or more epoxy groups within its molecule.

47. A polymer solid electrolyte according to any one of Claims 26 to 46, wherein the repeating unit represented by the Formula (II) is a repeating unit derived from a (meth)acrylate derivative having an epoxy group; and the cross-linking agent is an epoxy hardener.

48. A polymer solid electrolyte according to any one of Claims 26 to 47, wherein R₉ in the repeating unit represented by the Formula (II) is an organic group having a carboxyl group, and the cross-linking agent is an epoxy compound including two or more epoxy groups within its molecule.

49. A polymer solid electrolyte according to any one of Claims 25 to 48, wherein the electrolyte salt is at least one selected from the group consisting of alkali metal salts, quaternary ammonium salts, quaternary phosphonium salts, transition metal salts, and protonic acids.

50. A polymer solid electrolyte according to any one of Claims 25 to 49,

wherein the electrolyte salt is a lithium salt.

51. A polymer, comprising: a polymer segment (P1) having an ion-conductivity, a polymer segment (P2) not having an ion-conductivity, and a polymer segment (P3) having a cross-linking point disposed in an order of P3, P2, P1, P2, and P3.

52. A composition for a polymer solid electrolyte, comprising: a polymer segment (P1) having an ion-conductivity, a polymer segment (P2) not having an ion-conductivity, and a polymer segment (P3) having a cross-linking point disposed in an order of P3, P2, P1, P2, and P3; a cross-linking agent; and an electrolytic salt.

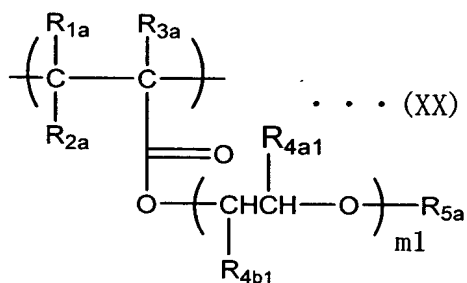
53. A polymer solid electrolyte, comprising a cross-linked polymer obtained by a reaction of a polymer with a cross-linking agent, and an electrolytic salt, wherein the polymer includes a polymer segment (P1) having an ion-conductivity, a polymer segment (P2) not having an ion-conductivity, and a polymer segment (P3) having a cross-linking point, the polymer being disposed in an order of P3, P2, P1, P2, and P3.

54. A polymer solid electrolyte battery, comprising: a solid electrolyte made into a film using the composition for a polymer solid electrolyte

according to any one of Claims 1 to 24 or the composition for a polymer solid electrolyte according to 52; and an electrode.

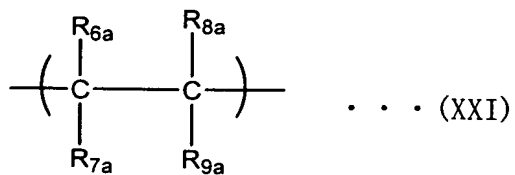
55. A polymer solid electrolyte battery, comprising: the polymer solid electrolyte according to any one of Claims 25 to 50 or the polymer solid electrolyte according to Claim 53; and an electrode.

56. A polymer solid electrolyte battery according to Claim 54 or 55, wherein the electrode comprises an electrode-activating compound and a copolymer including a disposition of block chains arranged in an order of B11, A11 and C11, wherein the block chain A11 includes a repeating unit represented by Formula (XX)



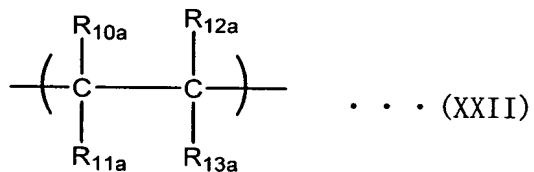
(wherein each of R_{1a} and R_{3a} independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R_{1a} and R_{3a} may bond to one another to form a ring; each of R_{4a1} and R_{4b1} independently represents a hydrogen atom or a methyl group; R_{5a} represents a hydrogen atom, a hydrocarbon group, an acyl group or a silyl group; m₁ represents an integer of 2 to 100; and R_{4a1} and R_{4b1} may be the same or different from each other), and the block chain

B11 includes a repeating unit represented by Formula (XXI):



(wherein each of R_{6a} to R_{8a} independently represents a hydrogen atom or a C1-C10 hydrocarbon group; and R_{9a} represents an aryl group).

57. A polymer solid electrolyte battery according to Claim 56 wherein the block chain C11 is a repeating unit represented by Formula (XXII)



(wherein each of R_{10a} to R_{12a} independently represents a hydrogen atom or a C1-C10 hydrocarbon group; and R_{13a} represents an aryl group or a heteroaryl group).

58. A polymer solid electrolyte battery according to Claim 56 or 57 wherein the position of the block chains of B11, A11 and C11 is B11-A11-C11.

59. A polymer solid electrolyte battery according to any one of Claims

56 to 58, wherein the copolymer includes 10 moles or more of the repeating unit represented by the Formula (XX).

60. A polymer solid electrolyte battery according to any one of Claims 56 to 59, wherein the copolymer includes 5 moles or more of the repeating unit represented by the Formula (XXI).

61. A polymer solid electrolyte battery according to any one of Claims 57 to 60 wherein the copolymer includes 5 moles or more of the repeating unit represented by Formula (XXII).

62. A polymer solid electrolyte battery according to any one of Claims 56 to 61, wherein m_1 in the Formula (XX) is an integer of 5 to 100.

63. A polymer solid electrolyte battery according to any one of Claims 56 to 61, wherein m_1 in the Formula (XX) is an integer of 10 to 100.

64. A polymer solid electrolyte battery according to any one of Claims 57 to 63, wherein R_{13a} in the Formula (XXII) is an aryl group, and the copolymer includes 5 or more of the repeating units represented by the Formula (XXII).

65. A polymer solid electrolyte battery according to any one of Claims 56 to 64, wherein a molar ratio $((XX)/((XXI)+C))$ of the repeating unit represented by the Formula (XX) to a total of the repeating unit represented by the Formula (XXI) and the repeating unit included in the block chain C is in a range of 1/30 to 30/1.

66. A polymer solid electrolyte battery according to any one of Claims 57 to 65 wherein a molar ratio of the repeating units represented by Formula (XX) to the total repeating units of those represented by Formula (XXI) and (XXII), i.e., $((XX) / ((XXI) + (XXII)))$ is in the range of 1/30 to 30/1.

67. A polymer solid electrolyte battery according to any one of Claims 56 to 66, wherein a number average molecular weight of the copolymer is in the range of 5,000 to 1,000,000.

68. A polymer solid electrolyte battery according to any one of Claims 56 to 67, wherein the cross-linked polymer is a copolymer having a microphase-separated structure.

69. A polymer solid electrolyte battery according to any one of Claims 56 to 68, wherein the electrode includes 0.5 to 15% by weight of the copolymer and the electrolytic salt.

70. A polymer solid electrolyte battery according to any one of Claims 56 to 69, wherein the electrode is an anode and includes an electroconductive material.

71. A polymer solid electrolyte battery according to Claims 56 to 68, wherein an anode is the electrode according to Claim 69, and a cathode is the electrode according to any one of Claims 56 to 69 or an alkali metal.

72. A polymer solid electrolyte battery according to any one of Claims 56 to 68, wherein an anode is the electrode according to Claim 70, and a cathode is the electrode according to any one of Claims 56 to 69 or an alkali metal.

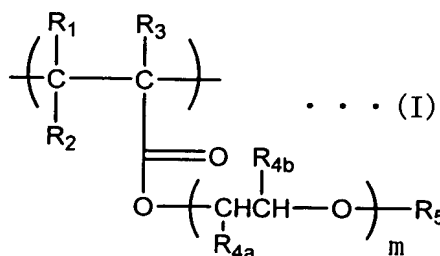
73. A polymer solid electrolyte battery according to any one of Claims 56 to 72, wherein the electrode further includes an electrolytic salt.

74. An ion-conductive membrane, comprising: a membrane which includes a polymer segment (P1) having an ion-conductivity, a polymer segment (P2) not having an ion-conductivity, and a cross-linked polymer segment (P4), wherein a network type microphase-separated structure is included in the membrane.

75. An ion-conductive membrane, comprising: a membrane containing a cross-linked polymer which is obtained by a reaction of a polymer with a cross-linking agent, wherein the polymer includes a polymer segment (P1) having an ion-conductivity, a polymer segment (P2) not having an ion-conductivity, and a polymer segment (P3) having a cross-linking point, wherein a network type microphase-separated structure is included in the membrane.

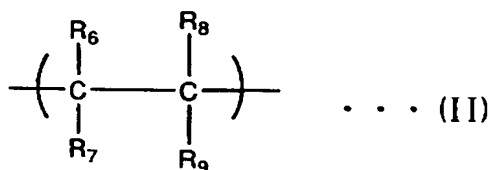
76. An ion-conductive membrane according to Claim 75, wherein the polymer including the polymer segment (P1) having an ion-conductivity, the polymer segment (P2) not having an ion-conductivity, and the polymer segment (P3) having a cross-linking point, forms a microphase-separated structure.

77. A copolymer having an arrangement of block chains in an order of B1, C1, A, C2, and B2, wherein the block chain A has a repeating unit represented by Formula (I):



(wherein each of R₁-R₃ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; R₁ and R₃ may bond to one another to form a ring; each of R_{4a} and R_{4b} independently represents a hydrogen atom or a methyl group; R₅ represents a hydrogen atom, a hydrocarbon group, an acyl group or a silyl group; m is an integer of 1 to 100, and each of R_{4a} and each of R_{4b} may be the same or different when m is 2 or more);

the block chain B1 has a repeating unit represented by Formula (II):

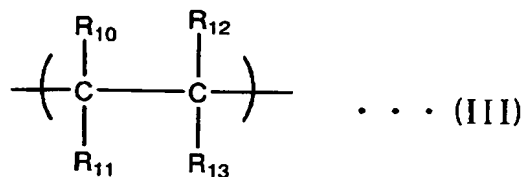


(wherein each of R₆ and R₈ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; R₆ and R₈ may bond to one another to form a ring; and R₇ represents a hydrogen atom, a C₁-C₁₀ hydrocarbon group, a hydroxyl group, a hydrocarbonoxy group, a carboxyl group, an acid anhydride group, an amino group, an ester group, or an organic group having at least one functional group selected from the group consisting of hydroxyl group, carboxyl group, epoxy group, acid anhydride group and amino group; R₉ represents an organic group having at least one functional group selected from the group consisting of hydroxyl group, carboxyl group,

epoxy group, acid anhydride group and amino group);

the block chain B2 having a repeating unit represented by the Formula (II) which may be the same or different from B1;

the block chain C1 has a repeating unit represented by Formula (III):



(wherein each of R₁₀ to R₁₂ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group, and R₁₃ represents an aryl group or a heteroaryl group); and

the block chain C2 has a repeating unit represented by the Formula (III) which may be the same or different from C1.

78. A polymer solid electrolyte according to Claim 77, wherein the arrangement in order of B1, C1, A, C2, and B2 is an arrangement in which units of B1-C1-A-C2-B2 are bonded.

79. A copolymer according to Claim 77 or 78, wherein a degree of polymerization of the repeating units represented by the Formula (I) is 5 or more.

80. A copolymer according to any one of Claims 77 to 79, wherein the

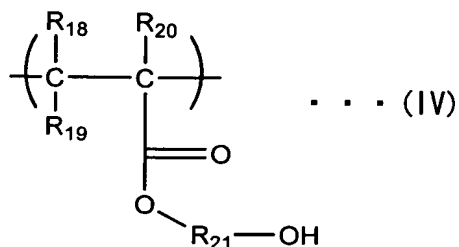
copolymer includes 5 moles or more of the repeating unit represented by the Formula (II).

81. A copolymer according to any one of Claims 77 to 80, wherein the copolymer includes 5 moles or more of the repeating unit represented by the Formula (III).

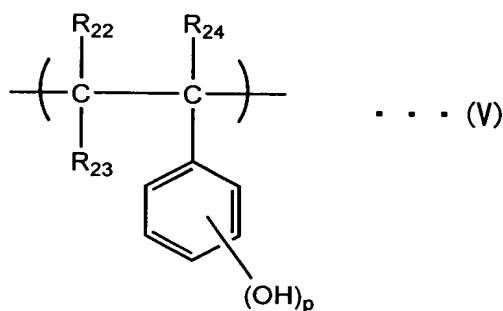
82. A polymer solid electrolyte according to any one of Claims 77 to 81, wherein, with respect to a total number of moles of the repeating units in the copolymer, a number of moles of the repeating unit represented by the Formula (I) is within a range of 9.9-80%, a number of moles of the repeating unit represented by the Formula (II) is within a range of 0.1-50%, and a number of moles of the repeating unit represented by the Formula (III) is within a range of 19.9-90%.

83. A copolymer according to any one of Claims 77 to 82, wherein a number average molecular weight of the copolymer is within the range of 5,000 to 1,000,000.

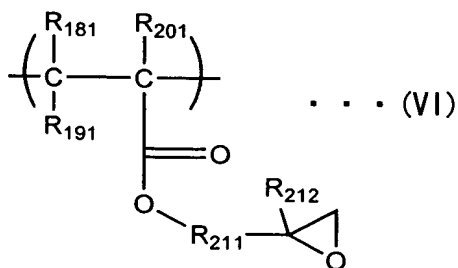
84. A copolymer according to any one of Claims 77 to 83, wherein the repeating unit represented by Formula (II) is a repeating unit represented by Formula (IV):



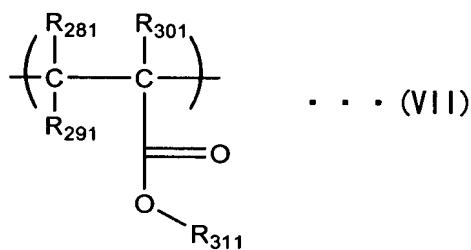
(wherein each of R₁₈ to R₂₀ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; R₁₈ and R₂₀ may bond to one another to form a ring; R₂₁ represents a C₁-C₆ alkylene group, a C₆-C₁₀ bivalent aromatic hydrocarbon group, a C₃-C₁₀ bivalent alicyclic hydrocarbon group or a bivalent organic group of a complex thereof), a repeating unit represented by Formula (V):



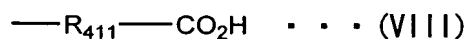
(wherein each of R₂₂ to R₂₄ independently represents a hydrogen atom or a C₁-C₁₀ hydrocarbon group; and p represents an integer of 1 to 3), a repeating unit represented by Formula (VI):



(wherein each of R₁₈₁, R₁₉₁ and R₂₀₁ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₁₈₁ and R₂₀₁ may bond to one another to form a ring; R₂₁₁ represents a C1-C6 alkylene group, a C6-C10 bivalent aromatic hydrocarbon group, a C3-C10 bivalent alicyclic hydrocarbon group or a bivalent organic group of a complex thereof; and R₂₁₂ represents a hydrogen atom or an alkyl group), or a repeating unit represented by Formula (VII)



(wherein each of R₂₈₁, R₂₉₁ and R₃₀₁ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₂₈₁ and R₃₀₁ may bond to one another to form a ring; and R₃₁₁ represents a hydrogen atom or a functional group represented by Formula (VIII)

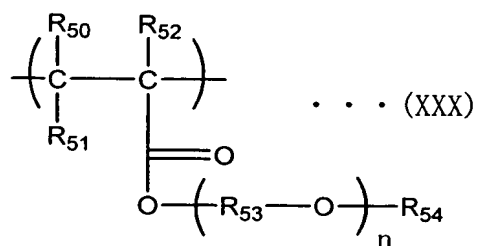


(wherein R₄₁₁ represents a C1-C6 alkylene group, a C6-C10 bivalent aromatic hydrocarbon group, a C3-C10 bivalent alicyclic hydrocarbon group or a bivalent organic group of a complex thereof)).

85. A copolymer according to any one of Claims 77 to 84, wherein the copolymer has a microphase-separated structure.

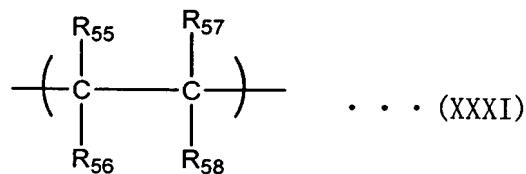
86. A method for producing the copolymer of any one of Claims 77 to 85, characterized by using a living radical polymerization method, wherein a transition metal complex is used as a catalyst and an organic halogen compound having one or more halogen atoms is used as a polymerization initiator.

87. A copolymer, comprising: a repeating unit represented by Formula (XXX):

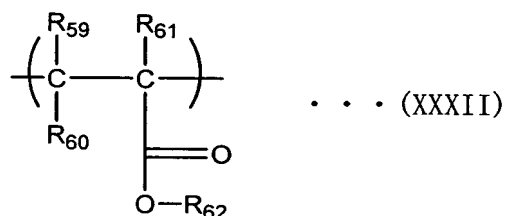


(wherein each of R₅₀ to R₅₂ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₅₃ represents a C1-C6 alkylene group having a linear or branched chain or a C3-C10 bivalent alicyclic hydrocarbon group; R₅₄ represents a hydrogen atom, a hydrocarbon group, an acyl group, or a silyl group; n is an integer of 1 to 100; and R₅₃ may be the same or different when n is 2 or more);

at least one repeating unit selected from a repeating unit represented by Formula (XXXI):

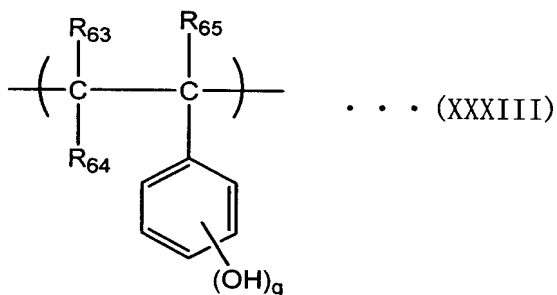


(wherein each of R₅₅ to R₅₇ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; and R₅₈ represents an aryl group or a heteroaryl group), and a repeating units represented by Formula (XXXII)



(wherein each of R₅₉ to R₆₁ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; R₅₉ and R₆₁ may bond to one another to form a ring; and R₆₂ represents a C1-C12 alkyl group, an aryl group, an alicyclic hydrocarbon group or a heterocyclic group); and

a repeating unit represented by Formula (XXXIII):



(wherein each of R₆₃ to R₆₅ independently represents a hydrogen atom or a C1-C10 hydrocarbon group; and q represents an integer of 1 to 3) which is different from the repeating unit represented by the Formula (XXXI).

88. A copolymer according to Claim 87 comprising 5 moles or more of repeating units represented by Formula (XXX).

89. A copolymer according to Claim 87 or 88, characterized by having 5 moles or more of at least one of the repeating unit selected from those represented by the Formula (XXXI) and (XXXII).

90. A copolymer according to any one of Claims 87 to 89, wherein the repeating unit represented by the Formula (XXX), at least one of the repeating units selected from those expressed by the Formula (XXXI) and (XXXII), and the repeating unit represented by the Formula (XXXIII) are block bonded.

91. A copolymer according to any one of Claims 87 to 90, wherein a number average molecular weight is in a range of 5,000 to 1,000,000.

92. A copolymer according to any one of Claims 87 to 91, wherein a mole number of the repeating unit represented by the Formula (XXX) with respect to a total number of moles of the repeating units in the copolymer is within a range of 5 to 99 mol%, and a mole number of the repeating unit represented by the Formula (XXXIII) with respect to a total number of

moles of the repeating units in the copolymer is within a range of 1 to 95%.

93. A copolymer according to any one of Claims 87 to 92, wherein a total of a number of moles of the repeating units represented by the Formula (XXX) and at least one of the repeating units selected from those represented by the Formula (XXXI) and (XXXII) is within a range of 5 to 99% with respect to a total number of moles of the repeating units in the copolymer, and a mole number of the repeating unit represented by the Formula (XXXIII) is in a range of 1 to 95% with respect to a total number of moles of the repeating units in the copolymer.